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ELECTRONIC GAME APPARATUS
[Denshi yugi kiki]

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SPECIFICATIONS /1*

[Title of the Invention]

Electronic Game Apparatus

[Claims] /2

[Claim 1] Electronic game apparatus, characterized in an electronic game apparatus for displaying a player moving object and another one or several moving objects around this together with a symbol for the above-mentioned player moving object by a display means as a radar map overlaid on the main display screen of the game, by fixing the above-mentioned symbol on the above-mentioned display means; presetting one or several radar detection range data for the above-mentioned radar map, providing a switching means operated by the above-mentioned player, selecting one of the above-mentioned radar detection range data based on a signal from the above-mentioned switching means, and changing the above-mentioned selected radar detection range according to changes in the position and travel direction of the above-mentioned player moving object as the game progresses; and displaying the above-mentioned other moving objects entered in the above-mentioned radar detection range by moving and rotating these relative to the above-mentioned symbol by the above-mentioned display means.

*Numbers in the margin indicate pagination in the foreign text.

[Claim 2] Electronic game apparatus described in Claim 1, wherein the display color of the above-mentioned symbol is a different color from the display color of the marks for the above-mentioned other moving objects.

[Claim 3] Electronic game apparatus described in Claim 1 or 2, wherein the above-mentioned radar detection range data are selected in a specific sequence each time the above-mentioned switching means is operated.

[Claim 4] Electronic game apparatus described in Claims 1 to 3, wherein the radar detection range is completely switched by gradually and continuously changing the display view when switching the display screen from one radar detection range to another radar detection range in response to operating the above-mentioned switching means.

[Detailed Explanation of the Invention]

[Industrial Field of Application]

This invention pertains to an electronic game apparatus. More particularly, this invention pertains to an electronic game apparatus displaying a so-called radar map of the surrounding area during play overlaid on part of the main video screen on the display screen, which is effective when a game-player (hereafter called "player") operates a moving object such as a car or airplane to play a game with other moving objects.

[Prior Art]

In prior art, the present applicants have offered an electronic game apparatus designed to accurately transmit the shape of a course and position data on other moving objects to a player by displaying the full movement range of moving objects or part of the surrounding area together with the moving objects when a player, for example, operates a moving object to play a game with other moving objects (Japan Application No. 4-279513). The present applicants have also offered an electronic game apparatus designed to provide a display screen having a feeling of solidity and reality to the player by applying three-dimensional processing to the main video screen using three-dimensional data (Japan Application No. 4-179040).

One of the games of moving objects while generating a main video screen by three-dimensional processing especially enjoyed in such electronic game apparatuses by prior art is the driving game. As shown in Fig. 6, for example, this game displays reduced view (220) of a drive course in positions around main video screen (200), which is an image viewed from the viewpoint of the driver (or behind the driver), and shows the present position of car (210) driven by the player (hereafter called the "player car") on this course by a means such as lighted display (222).

[Problems that the Invention is to Solve]

In electronic game apparatuses by prior art such as described above, other car (302) reflected in rearview mirror (300), for

example, must be monitored to ascertain the area around the player, especially the movement status of other cars impeding progress (hereafter called "other cars"). When the data used for displaying the environment, such as a drive course and data for displaying moving objects are stored in a memory or the like as three-dimensional data (polygon data) and the main video screen is generated by three-dimensional processing, however, the background image reflected in rearview mirror (300) requires a large additional amount of three-dimensional processing, and generating both a forward three-dimensional screen and a three-dimensional screen for the rearview mirror in real time is impossible using the capacity of current main processing units (hereafter called "MPU") and supplemental processing units (hereafter called coprocessors).

Games in which one enjoys cars hitting and being hit without knowing the status in the mirror view of the rearview mirror also have the problem that when one wants to know the status of other cars in the death space behind one or other cars being driven parallel to the left or right, one cannot know either one. This invention was developed in light of circumstances such as described above. The purpose of this invention is to offer an electronic game apparatus that quickly provides an accurate radar display of the position and travel direction of other moving objects around the player across all directions for 360°.

[Means of Solving the Problems]

This invention pertains to an electronic game apparatus. The purpose of this invention described above is achieved by an electronic game apparatus characterized in an electronic game apparatus for displaying a player moving object and another one or several moving objects around this together with a symbol for the above-mentioned player moving object by a display means as a radar map overlaid on the main display screen of the game, by fixing the above-mentioned symbol on the above-mentioned display means; presetting one or several radar detection range data for the above-mentioned radar map, providing a switching means operated by the above-mentioned player, selecting one of the above-mentioned radar detection range data based on a signal from the above-mentioned switching means, and changing the above-mentioned selected radar detection range according to changes in the position and travel direction of the above-mentioned player moving object as the game progresses; and displaying the above-mentioned other moving objects entered in the above-mentioned radar detection range by moving and rotating these relative to the above-mentioned symbol by the above-mentioned display means.

[Operation] /3

By making it possible to change the radar detection range by a switching means while keeping the player moving object fixed, this invention can achieve an easy-to-read radar map of the status of

other moving objects moving toward or away from the player across all directions for 360°, and can greatly reduce computation time.

[Working Examples]

Next, working examples of this invention will be explained in detail based on the figures. A working example of a driving game will be explained. In this invention, a radar map of the full movement range of moving objects is displayed in a specific position of the same display screen as in prior art overlaid on the main video screen while displaying the player car fixed at a separate display position of the same display screen, and the position and travel direction of all other cars that have invaded a specific radar detection range around this are displayed in a radar map centered on the player car within the fixed display described above. Therefore, when the player drives as play progresses, the player can know from the course map in what position the player car is driving within the full movement range, and can sense how many other competing cars are driving in the space near the player car to the left, right, or behind and in what direction. This gives the player a means for devising his or her latest game strategy.

Figure 1 is a block diagram showing one working example of the configuration of hardware in the electronic game apparatus of this invention. MPU (102) in this figure reads and executes game programs from ROM (106) where game programs and data are written, and also reads and writes various data to RAM (106) at times during the course

of a game such as when points are scored. Coprocessor (104) operates synchronized with MPU (102), and especially operates to aid numerical calculations and perform computations such as coordinate transformations at high speed. Operating parts (10) comprised of parts such as a push-button type switching means for switching, for example, the radar detection range or viewpoint, an accelerator, and a handle are connected to data processor (100) with input interface (110) as the portal, thus allowing player moving operations to be inputted to MPU (102) through operating parts (10) and input interface (110). Sound device (108) generates sounds such as specific sound effects, alarms, or artificial voice commands based on commands from MPU (102). The audio signals generated there are amplified by an audio amplifier not shown in the figure, then outputted through speaker (20) connected to data processor (100).

In addition, environment polygon data memory (120) for expressing a three-dimensional game environment such as a drive course as a colored three-dimensional polygonal solid, player car data memory (122) for storing three-dimensional solid data for displaying the player car and data during movement of the player car such as present position, travel direction, and speed, and other car data memory (124) for storing three-dimensional solid data for displaying normally several other cars and data during movement of individual other cars such as present position, travel direction, and speed are provided as memories housed in data processor (100)

separately from RAM/ROM (106).

Furthermore, viewpoint data memory (130) for specifying the viewpoint selected by switching means (10) and radar detection range data memory (130) for likewise specifying the radar detection range selected by switching means (10) are housed in data processor (100). To smoothly display these moved to their switched positions on the display screen when a viewpoint, radar detection range, or the like has been selected by switching means (10), the output data of data memory (130) are written through interpolation mover (132) to memories such as screen generation parameter memory (140), radar map parameter memory (144), or course map parameter memory (142).

Three-dimensional solid data are extracted from data memories (120), (122), and (124) as appropriate and written in screen generation parameter memory (140), data such as the present position and travel direction of the player car and other cars are extracted from data memories (122) and (124) as appropriate and written in radar map parameter memory (144), and course map data and the present position data of the player car are written by MPU (102) to course map parameter memory (142).

When data such as viewpoint data, three-dimensional polygonal data, moving object present position data, or radar detection range data have been stored in parameter memories (140) and (142) in this way, data such as three-dimensional polygonal data are projected onto the coordinate system of the display by coordinate transformation

device (150), depth data are found for each polygon, and two-dimensional polygon data for display are outputted to polygon paint device (152) sorted by depth data.

Furthermore, polygon paint device (152) executes processing such as coloring inside two-dimensional polygons, and the results are written in frame memory (154). The contents of frame memory (154) are read in sequence by television rate, converted to a video signal by a D/A conversion means or the like not shown in the figure, and displayed on the display means of monitor TV (30).

Next, the viewpoint switching/setting operation and radar detection range switching/setting operation by switching means (10) will be explained. First, the viewpoint on the display screen is changed based on the player's wishes by a viewpoint switching operation using ~~switching means (10) such as a~~ push-button switch. Switching means (10) may be arrayed next to the game start switch, combined with the game start switch, or provided on the handle.

As shown in Fig. 2, the viewpoints that can be switched or changed are set by selecting several locations ahead of time with the driver's seat of the player car as the base point. Figure 2 shows an example of viewpoints set at four points. Viewpoint ① is "just behind the player car," viewpoint ② is the "player viewpoint," viewpoint ③ is a "behind the player car from a low altitude," and viewpoint ④ is a "behind the player car from a high altitude." The specific three-dimensional coordinates of these viewpoints are written in viewpoint /4

data memory (130) as relative position vectors with the driver's seat of the player car as the base point. The same number of push-button switches as the number of viewpoints may be provided as switching means (10) with each switch corresponding to one of viewpoints ① to ④, or a single switch may be provided and the viewpoints switched sequentially (for example, viewpoint ① → viewpoint ② → viewpoint ③ → viewpoint ④ → viewpoint ①) each time this switch is depressed.

Similarly, the radar detection range is changed based on the player's wishes by a radar detection range switching operation using switching means (10), such as a push-button switch, and switching means (10) may be arrayed next to the game start switch, combined with the game start switch, or provided on the handle. The radar detection ranges that can be switched or changed are set as shown in Fig. 7 by selecting several ranges ahead of time with the driver's seat of the player car as the base point. Figure 7 shows an example of radar detection ranges set in four zones where the detection range becomes progressively larger from zone ① to ④. The specific three-dimensional coordinates of these detection zones are written in radar detection range data memory (130) as relative position vectors with the driver's seat of the player car as the base point. The same number of push-button switches as the number of radar detection ranges may be provided as switching means (10) with each switch corresponding to one of zones ① to ④, or a single switch may be

provided and the detection range switched sequentially (for example, zone ① → zone ② → zone ③ → zone ④ → zone ①) each time this switch is depressed.

To explain this operation using such a configuration referring to the figures, first, when a game such as a driving game has been started by a player stepping on the accelerator, the accelerator and the direction of the handle are checked at a specific cycle (for example, by units of 1/60 second) by MPU (102) through switching means (10) and input interface (110), the present position and travel direction data of the player car while moving on the course are changed, and the contents of player car data memory (122) are updated. The present position and travel direction data of several other cars participating in this driving game are also updated and the contents of other car data memory (124) rewritten by this timing.

Next, the output of switching means (10) is inputted to MPU (102), which checks whether or not a viewpoint switching operation was performed and whether or not a radar detection range switching operation was performed.

If neither operation was performed, viewpoint ① and radar detection zone ①, for example, are selected as default data. Because no switching operation was performed at this time, interpolation mover (132) is not operated, the three-dimensional data for viewpoint ① are read from data memory (130) and written in environment display parameter memory (140), and the three-dimensional data for radar

detection zone ① are read from data memory (13) and written in radar map parameter memory (144).

Next, MPU (102) executes processing to generate a three-dimensional screen. In this processing, first, the three-dimensional polygon data for video display stored in data memories (120) and (124) are checked by MPU (102), and all three-dimensional polygons visible from viewpoint ① at the present time with reference to the player car are extracted and written in screen generation parameter memory (140). In this processing, for example, three-dimensional polygon data satisfying the following formula may be extracted by MPU (102), where v is the directional vector of the viewpoint at viewpoint ① and n is the normal vector of the three-dimensional polygon:

[Equation 1] $v \cdot n > 0$

When all three-dimensional solid data stored in environment polygon data memory (120), player car data memory (122), and other car data memory (124) have been checked in this way and the three-dimensional polygons visible from viewpoint ① at the present time have been extracted, the distances (or depth data) between these three-dimensional polygons and viewpoint ① are calculated by MPU (102), and the above-mentioned three-dimensional polygons are sorted based on the depth data so as to leave only the polygon closest to viewpoint ① in each direction of the visual field, then these are stored again in screen generation parameter memory (140).

After this, viewpoint vectors and the three-dimensional polygon data sorted as described above are read from screen generation parameter memory (140) by coordinate transformation device (150), and two-dimensional polygon data for display are generated by executing video generation computation and transmitted to polygon paint device (152). Furthermore, polygon paint device (152) takes the wire frame data of the two-dimensional polygon data and paints in the polygon using the color data such as hue, saturation, or brightness indicated, then writes the colored two-dimensional polygon in frame memory (154). This state is shown by (200) in Figure 4. This completes the processing for generating a three-dimensional video image of the environment and the moving objects at viewpoint ①.

Next, MPU (102) executes processing to generate a course map. In this processing, two-dimensional course map data are extracted from environment polygon data memory (120) and written in course map parameter memory (142), and the present position data of the player car and the player car symbol data for the course map are extracted from player car data memory (122) and written in course map parameter memory (142).

After this, the two-dimensional course map data described above are transformed to a specific position on the display screen by coordinate transformation device (150) and colored by polygon paint device (152), then written in frame memory (154). This state is shown /5
by (220) in Fig. 4. The player car symbol is also transformed to

specific position on the course map by coordinate transformation device (150) and colored by polygon paint device (152), then written to frame memory (154). This state is shown by (222) in Fig. 4.

Next, MPU (102) executes processing to generate a radar map. In this processing, the detection space data of radar detection zone ① have already been written in radar map parameter memory (144) by checking whether radar detection range switching means (10) is on or off. Therefore, first, the present position of player car P-CAR and the player car symbol data for the radar map are read from player car data memory (122) and written in radar map parameter memory (144), and radar detection zone ① is set with reference to P-CAR (step S2).

Next, the effective radar range when this detection zone ① is viewed from a viewpoint a specific distance above P-CAR is multiplied by a specific multiplication factor by coordinate transformation device (150) and written in a specific position of frame memory (154) by way of polygon paint device (152) (step S4). One example of this state is shown by box (230) in the upper right of Fig. 4. Next, the player car symbol data are read from radar map parameter memory (144) by coordinate transformation device (150) and transformed to specific coordinates, then colored by polygon paint device (152) and written in the center position of the radar map in frame memory (154) (step S6). One example of this state is shown by (232) in Figure 4.

When the present position of the player car and the initial setting of radar detection zone ① are completed, all other cars O-CAR

are checked for whether or not they can be detected by radar. First, the present position of the first O-CAR is read from other car data memory (124) (step S8), and the relative position between this O-CAR and P-CAR is calculated by MPU (102) (step S10). Next, it is checked whether the relative position described above is within the range of radar detection zone ① (step S12). If it is within the range of zone ①, the position and travel direction of the other car are read together with the other car symbol from other car data memory (124) and written in radar map parameter memory (144). Next, after starting up coordinate transformation device (150), the other car symbol data are read together with the position and travel direction data and transformed to specific coordinates, then colored by polygon paint device (152) and written in frame memory (154) (step S14). One example of this state is shown by (234) in Fig. 4.

If it is outside of the range of radar detection zone ①, on the other hand, other car display step S14 described above is skipped and it is checked whether radar detection processing has been completed for all O-CAR (step S16). If radar detection processing has not been completed for all O-CAR, the present position of the next O-CAR is read from other car data memory (124) (step S18) and the processing returns to step S10. If radar detection processing has been completed for all O-CAR, the radar map display routine ends. Thereafter, the video generation processing, course map display processing, and radar map display processing described above are repeated at a specific

timing (for example, every 1/60 second).

Moreover, radar detection ranges were described in the above explanation as rectangular parallelepiped spatial zones as shown in Fig. 7, but spherical or elliptical radar detection zones can also be employed. In addition, an example displaying both the course map and the radar map overlaid on the main video screen was described in the above explanation, but displaying the course map can be omitted. Furthermore, the display screen becomes extremely hard to view when the viewpoint or radar detection range is changed by units of 1/60 second in direct response to a switching operation when changing the viewpoint or radar detection range by operating switching means (10). Therefore, it is preferable to set the viewpoint movement interval and the radar detection range movement interval independently from each other to an interval such as 0.2 second to several seconds, and move the viewpoint or change the radar detection range smoothly by linearly interpolating to a newer viewpoint or radar detection range by interpolation mover (132) while ignoring any change in output from switching means (10) during these movement intervals.

Moreover, this working example described a so-called driving game, but is not limited to this, and clearly can be applied to all types of games by practitioners in the art. In addition, this invention can be applied by businesses such as game centers or used in private homes.

[Effects of the Invention]

As explained above, the electronic game apparatus of this invention can quickly reveal the position and orientation of other moving objects around the player car across all directions for 360° without using the rearview mirror. As shown in Figs. 5(A) to (C), this invention also makes it easy to see the state of a car after it has been hit and extremely easy to judge distances from other cars in games in which one enjoys crashing and being crashed, thus increasing the enjoyment of the game. Furthermore, because it does not require coordinate transformation processing using three-dimensional polygon data to generate a rearview mirror video image, this invention can decrease the load on the microprocessor.

[Brief Explanation of the Figures]

[Figure 1] Block diagram showing one example of the hardware configuration of the electronic game apparatus of this invention.

[Figure 2] Diagram showing one example of setting viewpoints in an electronic game apparatus of this invention.

[Figure 3] Flowchart showing the display sequence of a radar map in the electronic game apparatus of this invention.

[Figure 4] Diagram showing a specific display screen in one working example of the electronic game apparatus of this invention. /6

[Figure 5] Diagram showing that status of movement of other cars ascertained by radar.

[Figure 6] Diagram showing a specific example of a rearview mirror video image display screen by prior art.

[Figure 7] Diagram showing one example of spaces used for setting radar detection ranges in this invention.

[Explanation of Reference Numerals]

10 operating parts

20 speaker

30 monitor TV

100 data processor

102 MPU

106 ROM/RAM

110 input interface

120, 122, 124 data memories

130 radar detection range and viewpoint data memory

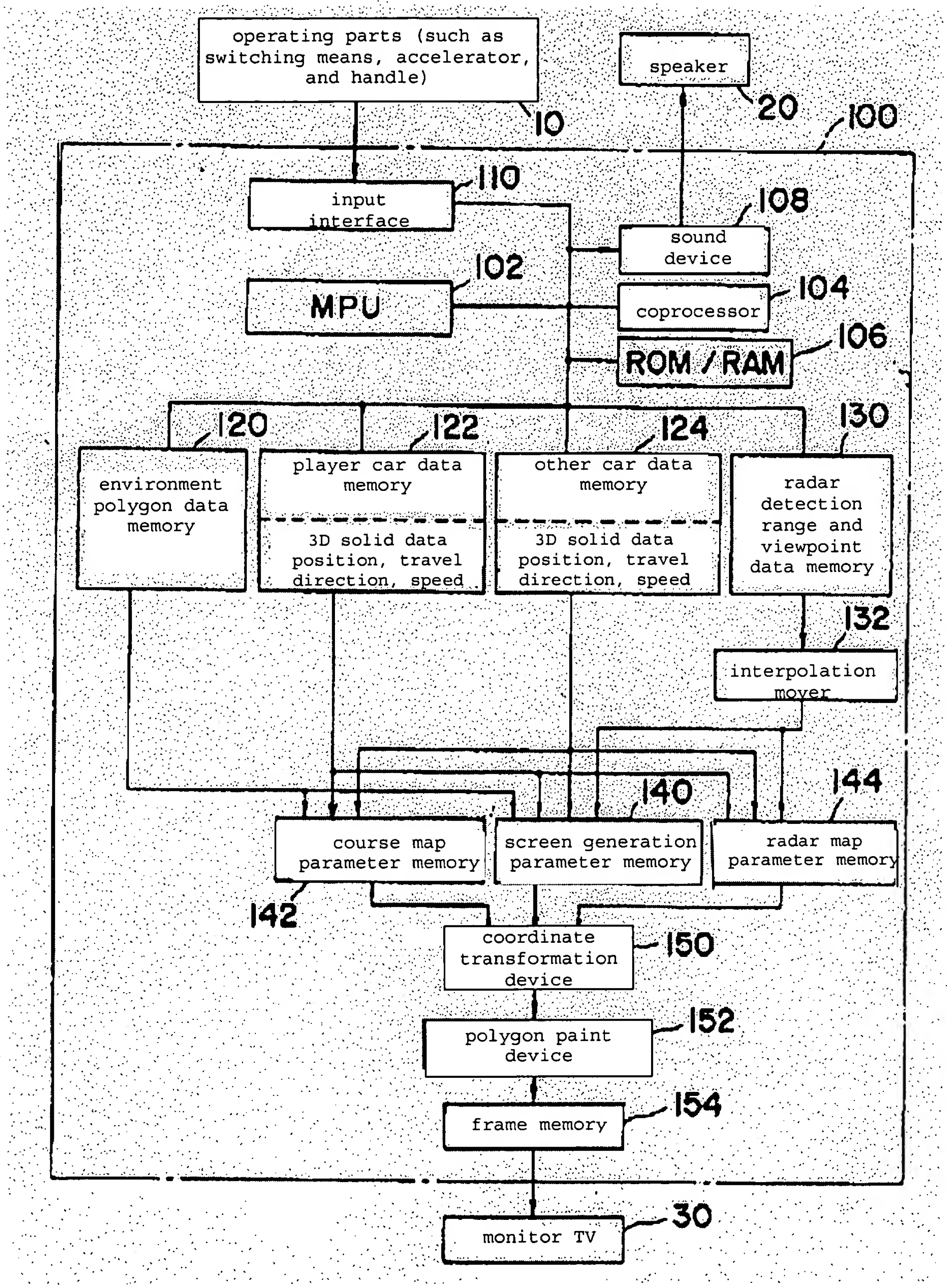
132 interpolation mover

140, 142, 144 parameter memories

150 coordinate transformation device

152 polygon paint device

154 frame memory



operating parts (such as switching means, accelerator, and handle)
speaker
20
10
100
input interface
110
108
sound device
102
MPU
coprocessor
104
ROM / RAM
106
120
122
124
130
environment polygon data memory
player car data memory
3D solid data position, travel direction, speed
other car data memory
3D solid data position, travel direction, speed
radar detection range and viewpoint data memory
132
interpolation mover
140
144
course map parameter memory
screen generation parameter memory
radar map parameter memory
142
coordinate transformation device
150
polygon paint device
152
frame memory
154
monitor TV
30

Figure 1

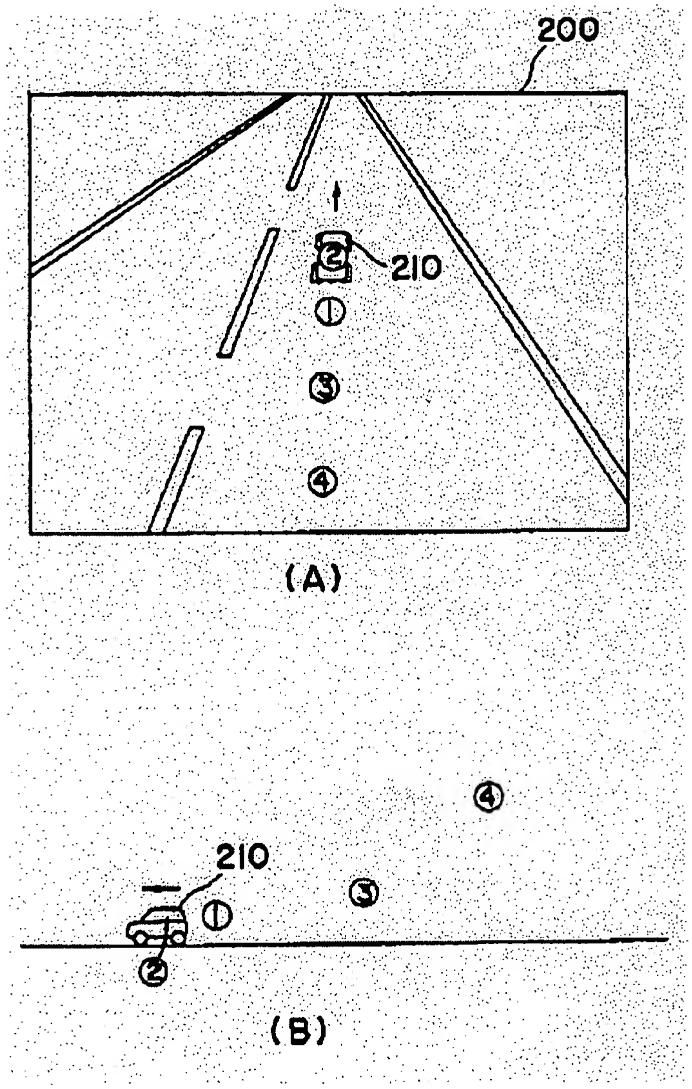


Figure 2

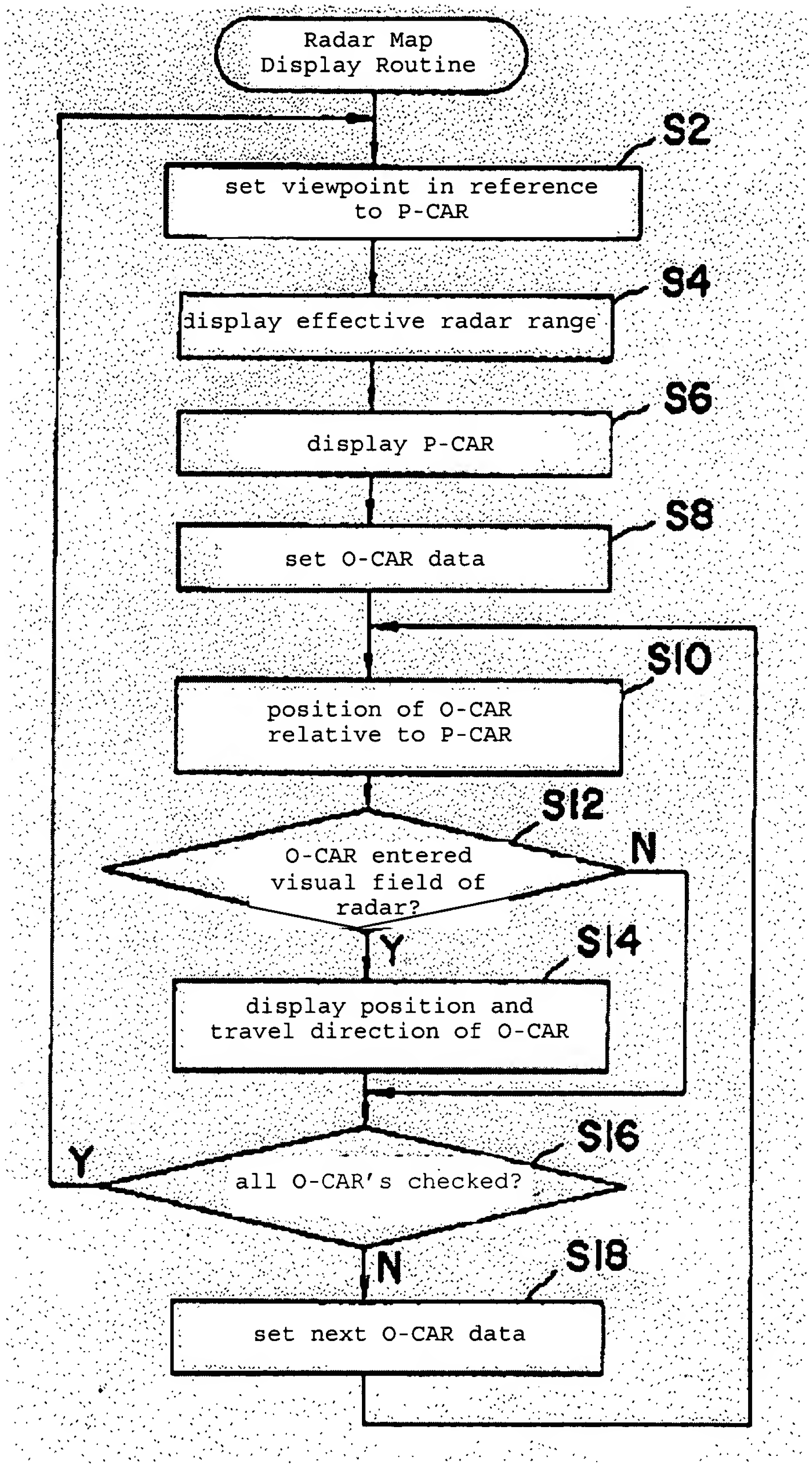

Radar Map
Display Routine
S2
set viewpoint in reference to P-CAR
S4
display effective radar range
S6
display P-CAR
S8
set O-CAR data
S10
position of O-CAR relative to P-CAR
S12
O-CAR entered visual field of radar?
N
Y
S14
display position and travel direction of O-CAR
S16
Y
all O-CAR's checked?
N
S18
set next O-CAR data

Figure 3

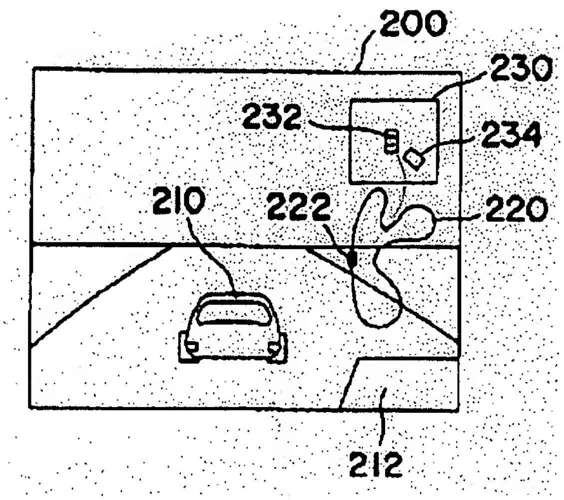


Figure 4

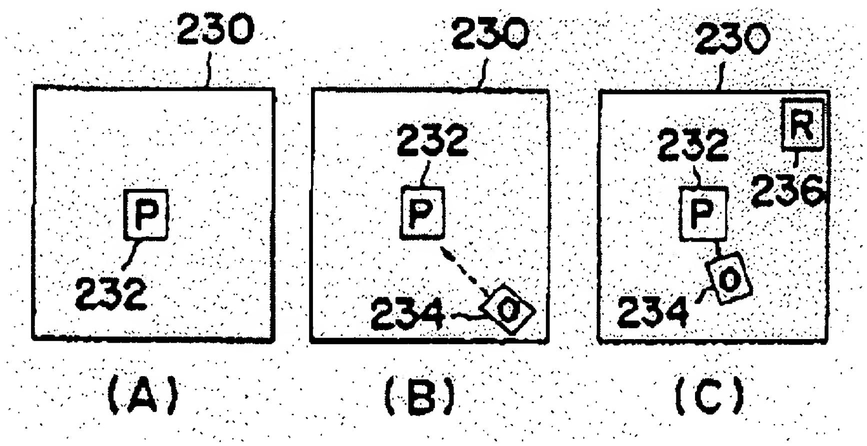


Figure 5

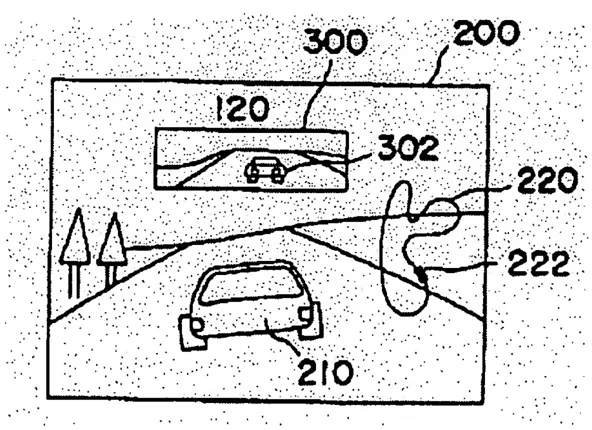


Figure 6

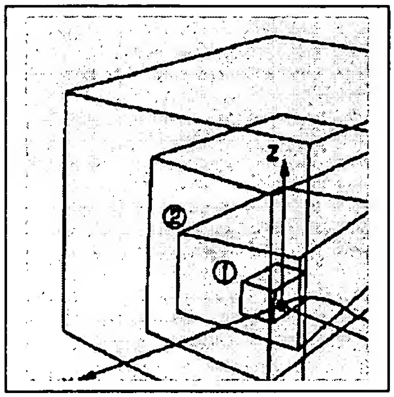


Figure 7